

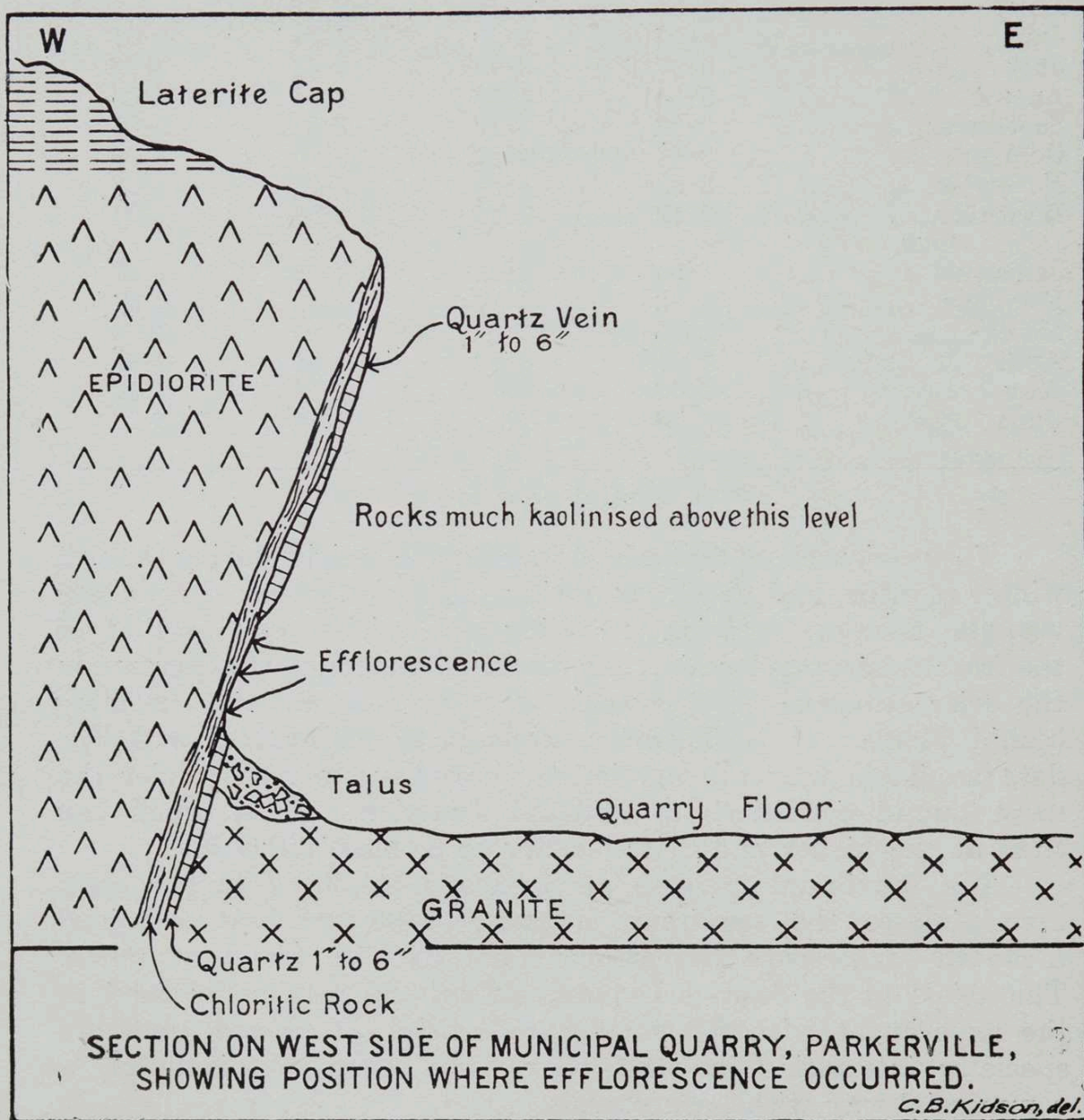
COBALTIFEROUS EPSOMITE AT PARKERVILLE.

By EDWARD S. SIMPSON, D.Sc., B.E., F.C.S., Government Mineralogist and Chemist.*

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At the end of the summer of 1918-19 a white efflorescence was observed on a sheltered portion of the western wall of the Municipal Quarry at Parkerville. This township is situated in the midst of the immense granite massif of the Darling Ranges, the granite being traversed by a network of large epidiorite dykes and by pegmatite and quartz veins, with occasional narrow greenstone (camptonite or dolerite) dykes of much later date. The quarry has exposed large faces of epidiorite and granite, both completely kaolinised near the surface, but passing into solid rock at depths of 1.5 to 6.0 metres. The surface in the vicinity is covered with laterite.

Fig. 13.



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The exact situation of the efflorescence relative to the rocks mentioned is indicated in the accompanying section (Fig. 13). It formed a soft loose white powder, three to twenty-five mm. thick, in discontinuous masses on the surface of a thin band of chlorite rock (altered camptonite or the crushed selvage of the epidiorite) lying between a large epidiorite dyke on the west side, and a narrow quartz vein, flanked by granite, on the east side. The efflorescence was distributed over a face about 15 metres long and one metre high. It was found impossible to collect it entirely free from chloritic dust, but the material chosen for analysis, which was collected over about 0.2 square metres of rock, contained only ten per cent. of rock dust insoluble in water. The analysis of the water-soluble portion showed:—

		Epsomite, Parkerville.			
		%	mols.		
MgO	...	16.59	4,116	}	4,272
CoO	...	.70	93		
NiO	...	.39	52		
CuO	...	.09	11		
CaO	...	1.36	243	}	4,515
FeO, Fe ₂ O ₃ , Al ₂ O ₃	Nil	...	...
SO ₃	...	36.05	4,503		
H ₂ O	...	[44.82]	24,872		
		100.00			

The figures may be restated thus:—

MgSO ₄ ·nH ₂ O	...	91.78	}	Epsomite
CoSO ₄ ·nH ₂ O	...	2.41		
NiSO ₄ ·nH ₂ O	...	1.34		
CuSO ₄ ·nH ₂ O	...	0.30		
CaSO ₄ ·2H ₂ O	...	4.17	}	Gypsum.
		100.00		

In this statement n is 5.717 (*vide infra*).

The analysis indicates in the first place that the efflorescence is essentially epsomite, mixed with a small percentage of gypsum. The presence of appreciable amounts of cobalt, nickel, and copper sulphates co-crystallised with the magnesium sulphate appears to be almost unique, the only other occurrences found in the literature being that of Neusohl (Hungary)*, where the mineral was rose red

*Dana, 1889 Edit., p. 644.

in colour, and was found by Stromeyer to contain 0.38 of CuO and 0.69 of CoO, no information being given as to the quantity of NiO, if any, present. A nickel sulphate, morenosite, $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$, is known which is orthorhombic, and is isomorphous with epsomite, but the only known cobalt sulphate, bieberite, $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$, is monoclinic. The compound $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ is, however, known to crystallise under artificial conditions in both orthorhombic and monoclinic forms, the latter isomorphous with bieberite. It is clear therefore that the three heptahydrated sulphates of magnesium, nickel, and cobalt are isodimorphous. The crystalline form of the Parkerville mineral was indeterminable.

The absence from the salt of all traces of iron and aluminium, both of which are far more abundant in the rock matrix than either cobalt or nickel, is at first sight remarkable, since the efflorescence can only originate in the oxidation of pyrite or pyrrhotite embedded in the igneous rocks which moreover contain a large proportion of alumina. A cobaltiferous pyrrhotite is the most probable source. There are, however, no large bodies of sulphides in the vicinity so that the solutions produced by the weathering pyrrhotite would be only weakly acid and would rapidly be neutralised by interaction with the abundant chlorite, giving a neutral solution of sulphates of magnesium, cobalt, nickel, ferrous iron, and probably aluminium. Whilst such solutions of magnesium, cobalt, and nickel are very stable, neutral sulphate solutions of iron and aluminium in the presence of oxygen rapidly precipitate simple basic salts or compound basic salts with alkalis (alunite, jarosite, etc.). Hence it arises that the final efflorescence contains neither iron nor aluminium.

The ratio of water and sulphuric oxide to protoxides in the Parkerville mineral, after allowing for the gypsum present, is :

(Mg, Co, Ni, Cu) O	...	1,001
SO ₃	... ..	999
H ₂ O	... ..	5,717

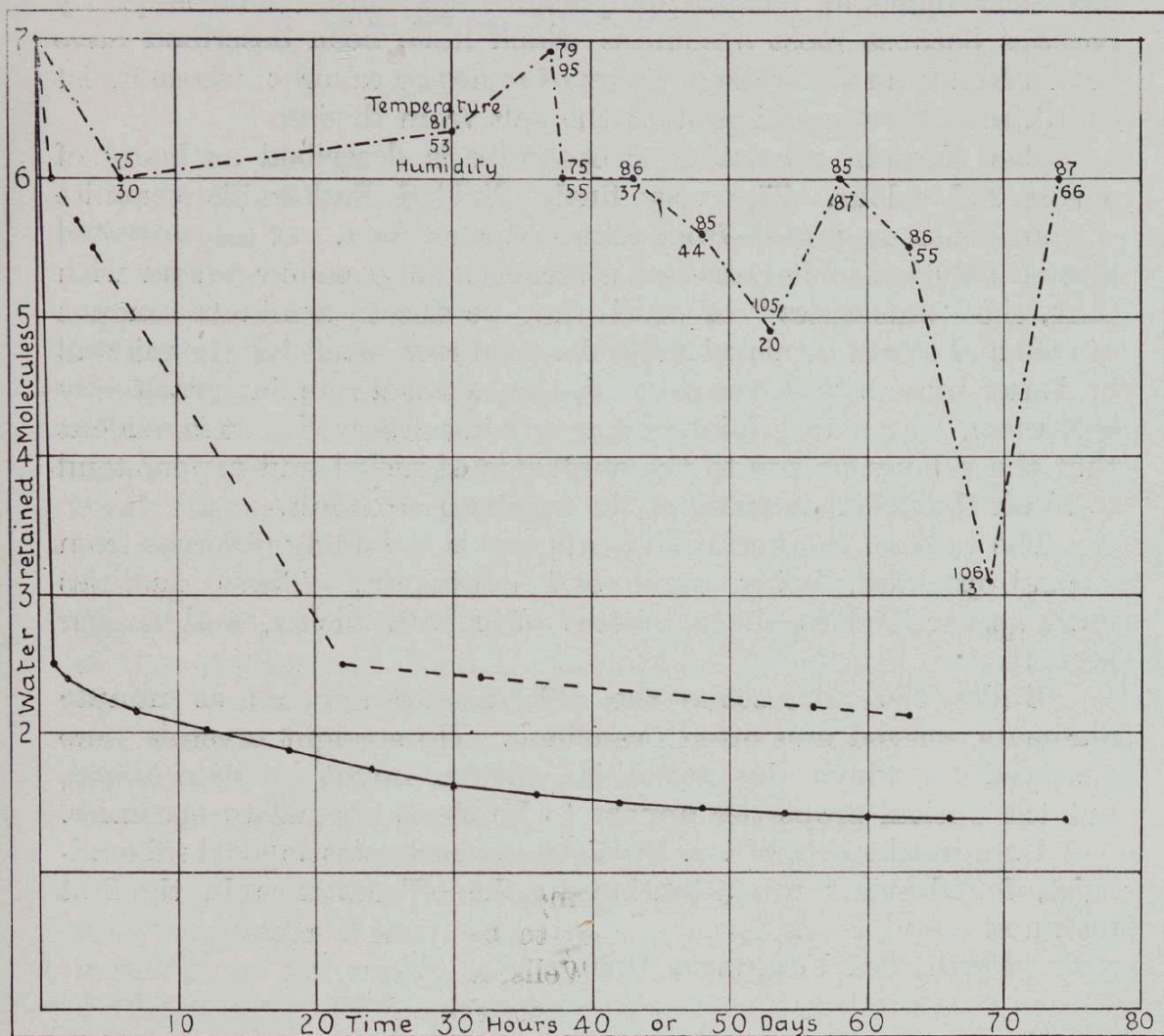
The SO₃ and protoxides balance well but the water is far below the normal ratio of 7:1. The artificial heptahydrate of magnesium sulphate (epsom salts) is known to be efflorescent and "loses its water by stages, and with decreasing aqueous tension."*

Experiments made in the author's laboratory to obtain more precise information on this point, yielded the curves shown in Fig. 14. These experiments showed (top curve) that under ordinary atmospheric conditions $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ loses water of crystallisation temporarily in proportion to the rise of temperature and fall of humidity, the maximum loss recorded being almost four

*Alex. Smith: Introduction to Inorganic Chemistry, p. 644.

molecules. With lower temperatures and increased humidity the salt reverts to its original condition of hydration.

Fig. 14.



Graph showing Dehydration of Epsomite.

Top curve, in air. Time units, days. Temperature, Fahrenheit degrees.

Middle curve, over sulphuric acid. Time units, days.

Bottom curve, in steam oven. Time units, hours.

Drying by heating at 100 degrees (bottom curve) or by keeping in a desiccator over strong sulphuric acid (middle curve) showed a rapid drop to $\text{MgSO}_4 \cdot 2\frac{1}{2}\text{H}_2\text{O}$ and thereafter a very slow but regular loss of water with slowly decreasing tension.

It appears from these results that epsomite exposed to the atmosphere will vary in water content, possibly down to $\text{MgSO}_4 \cdot 2\frac{1}{2}\text{H}_2\text{O}$, but will recover to its normal composition in cool damp weather. It is evident therefore that the abnormality in water content of the Parkerville mineral is due to a temporary partial dehydration brought about by the dry and hot atmosphere prevailing in the locality during the summer time, the efflorescence

being exposed during part of the morning to the direct rays of the sun. In view of the known tendency of artificial epsom salts to become partly dehydrated, it is surprising that no previous record has been made of natural dehydrated epsomite. This is partly perhaps because most epsomites which have been described have been taken from the walls or floors of mines or caverns, whose moist cool atmosphere would protect the salt from drying.

The Neusohl cobaltiferous epsomite is described as being of a rose red colour. The very finely divided Parkerville epsomite is pure white or greyish from admixed rock dust. A concentrated filtered solution of it possesses a strong smoky colour tinged with pink, the "smokiness" of which may be due to a minute amount of colloidal cobalt or nickel sulphide. On recrystallising the mineral in denser masses than the original, the salt still remains practically colourless, only a very faint pinkness being observed. It is evident that the colours proper to the sulphates of nickel and copper tend to mask that characteristic of the sulphate of cobalt.

The taste of the Parkerville mineral is strikingly different from normal epsomite, being acrid and astringent. These qualities must be ascribed to the sulphates of cobalt, nickel, and copper present.

Under the microscope the efflorescence appears as minute filaments, curved and often branching. No straight crystals were observed by which the crystalline system might be determined, but the optical properties appear to be those normal to epsomite.

I am indebted to Mr. J. E. Wells, an enthusiastic local mineralogist, for drawing my attention to the efflorescence in the first instance.

Perth, 3rd February, 1920.
